Volume 18 February, 1932 *Number 2*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

PUBLISHED BY

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Meeting Load Demands in Industry

Adaptability of the Roller Bearing

INCREASE in the size and speed of certain types of machinery, during the past few years, has developed a load requirement so pertinent to bearing construction as to necessitate radical changes in bearing design and methods of lubrication. More than ever, has the need for positive and dependable lubrication become apparent. This has required numerous changes in bearing seal construction and increase in the load carrying capacity of lubricants. Of chief interest, however, has been the transition from the traditional plain or sleeve-type bearing to the roller bearing. Developments in this regard have been especially extensive in the iron and steel industry, on paper mill machinery and in steam railway service.

Steel Mill Conditions

The problems pertinent to the operation of steel mill bearings vary widely. Loads are frequently excessive, vibration is virtually continuous, and the prevailing shocks which result from impact of ingots or billets upon the roll surfaces react upon the roll neck bearings in practically any type of mill. The same holds true on ingot and charging car bearings. Unless the resultant loads can be readily carried by the bearing lubricant, and unless there is adequate provision to prevent squeezing out of this latter, the life of the bearing will be markedly reduced. Somewhat similar conditions prevail in the operation of hot saws. Here, however, there is the added element of speed which, coupled with the severity of the load and the frequency with which it must be absorbed in its full intensity by the bearings, often subjects the saw mountings to duty so severe as to materially reduce their effective life.

But load, shock, vibration, speed, and high temperature are not the only factors which must be considered in a study of steel mill bearings and their lubrication. One must also realize that the contaminating effects of dust, dirt and water, as well as the abrasive nature of the former, may lead to impaired lubrication and abnormal bearing wear.

The Paper Industry

The paper industry, in turn, is unique in regard to the variety of problems which may prevail to affect lubrication. Starting with the products, one must not only take the utmost care to protect the lubricants themselves in storage and transit to the lubricating systems, but also every consideration must be given to the detriments and cost of oil-contaminated felt surfaces, and the paper itself.

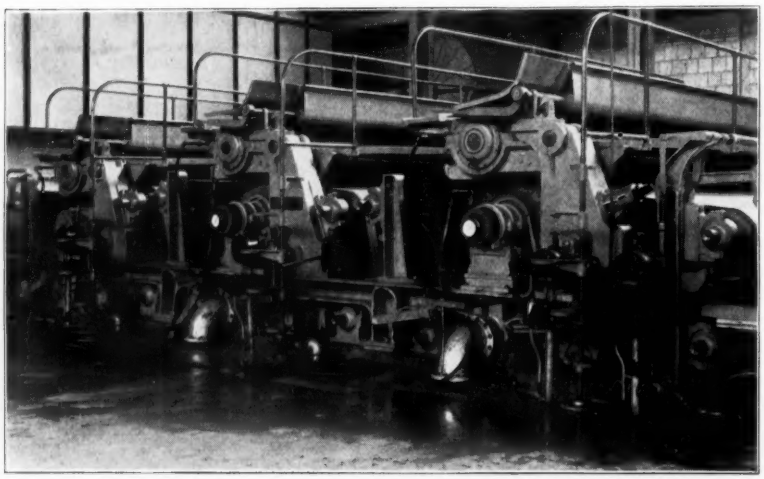
Service conditions, in addition, will involve high pressures, temperatures, and the possibility of entry of water and paper pulp into the lubricating systems.

Realization of the extent to which the above might affect the cost of production has prompted keen interest on the part of paper mill executives, machinery builders and the petroleum industry, in development of means of counteracting premature bearing failure, protection of paper stock, and formulation of methods of lubrication which will enable the modern high

grade lubricants to effect sustained lubrication with the maximum of dependability at the least possible cost per ton of paper produced.

Steam Railway Operations

In railway service the importance of bearings has likewise been fully realized. In particular developments in roller bearing construction have focussed attention upon the adaptability and advantages of such mechanisms. As a consequence, application of the roller bearing to steam railway service may be regarded as one of the outstanding improvements in rolling stock design. It has been an interesting transition from the prevailing opinion in the minds of many railway equipment operators that the plain bearing was irreplaceable.



Courtesy of SKF Industries, Inc.

Fig. 1—Side view, showing press felt and top press rolls on a Pusey and Jones paper machine, equipped with roller bearings.

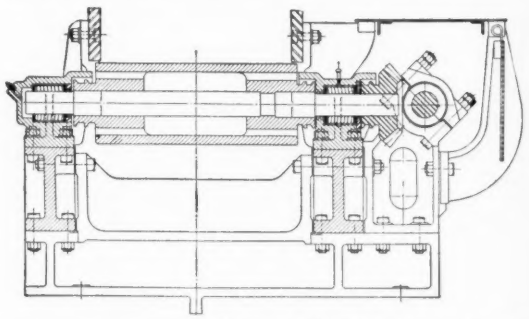
The probable thrusts involved are oftentimes decided factors in bearing operation. Load as well as lateral thrusts are developed in any such bearing placed on a journal. As a result, this should be given careful consideration. Should construction involve inaccurate machine work, distribution of lubricant might easily be impaired, for lubrication of the plain bearing is dependent on the movement of the journal to carry oil upwards from a supply of waste saturated in car oil, to establish and maintain a lubricating film between the bearing and the journal. The saturated waste is retained in the journal box in contact with the under side of the journal, flow of oil depending on capillary feed and contact retention. The extent to which continued lubrication can be maintained will depend upon the success with which the method of oil distribution functions in the presence of the opposing natural forces and the effect of the elements.

The practical operator has for years been cognizant of these conditions under which his machinery must function, but he has not always been able to combat them effectively, due to the types of bearings heretofore available, and the fact that the sleeve-type plain bearing could not always be so constructed as to retain its lubricant in a dependable manner. Perhaps this was also a reason for a lack of study of this phase of lubrication engineering until recent years.

IMPORTANCE OF LUBRICANT SEALS

The development of the heavy duty roller bearing has been particularly noteworthy from the viewpoint of the efforts of the designers to work out effective lubricant sealing features in the form of labyrinths, slingers, seal rings, and cup leather seals. Retention of the lubricant was early appreciated as being a most important feature. Obviously, protection of the surfaces of the bearing elements could not be assured were leakage of lubricants to prevail, and with this lack of protection, failure of a bearing under intense load might easily occur.

It was also important to study sealing devices by reason of the high temperatures under which so many steel and paper mill bearings, in particular, must operate. The effect of such temperatures is to reduce the viscosity or consistency of any lubricant. The extent to which this will occur depends of course upon the original body of the product. Unless the latter is of the nature of steam cylinder oil with a viscosity in the neighborhood of 130 seconds



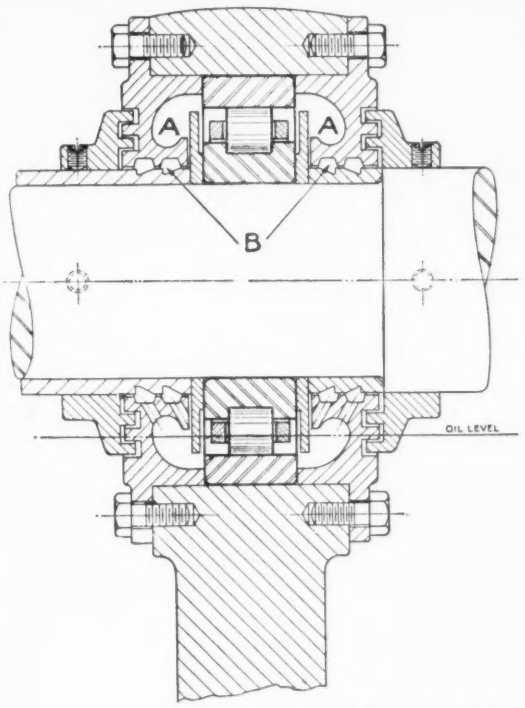
Courtesy of Hyatt Roller Bearing Company

Fig. 2—Sectional view of a steel mill runout table, equipped with grease lubricated helical roller bearings.

Saybolt, or above, at 210 degrees Fahr., at steel mill temperatures considerable leakage may result from certain types of bearings. It is for this reason that steam cylinder stocks are used in certain grades of roll neck greases.

Where an adequate bearing seal can be provided, as is customary in the design of the majority of roller bearings employed in such service, leakage, even under extreme temperatures, can be prevented to a marked degree. In this connection, a discussion of the various types of seal design will be of particular interest.

In the earlier developments of sealing media, felt and leather washer and grease-groove seals proved their adaptability and were comparatively inexpensive and simple in design. By virtue of these advantages, they are still retained by many bearing manufacturers. Since their development, however, other types of seals have come into usage including metallic rings similar to piston rings, mercury baths in connection with vertical installations, and metallic springs for the purpose of maintaining

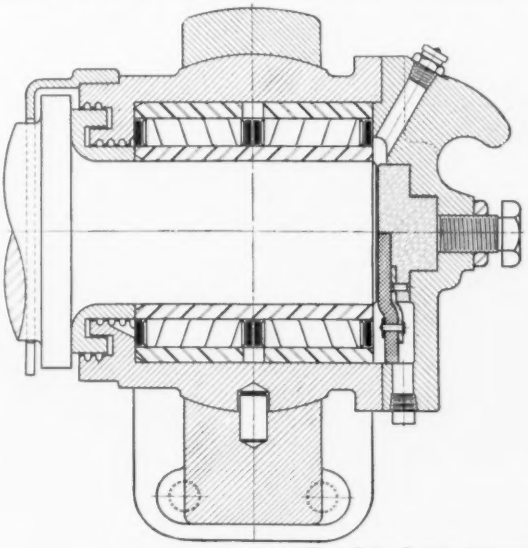


Courtesy of Norma-Hoffmann Bearings Corp.

Fig. 3—Showing a roller bearing housing, designed to prevent oil leakage. A slinger at the outer side of the bearing throws off oil, which is directed against the inner surface of the housing to be caught in channel A. Supplementary oil grooves are shown at B.

the adjustment of felt, leather, and cork with respect to shafting, journals or roll necks.

The primary objective in the selection of a suitable grease or oil seal is to obtain a design which will not show material wear in service, otherwise the purpose may be more or less defeated. Washer type felt or leather seals will have this tendency, although the rate of wear will depend upon the quality of the material. Where adjusting springs are used in connection with similar material, however, to automatically keep the seal in close contact with the



Courtesy of Hyatt Roller Bearing Company

Fig. 4—Details of a helical roller bearing on a paper mill breast roll mounting. Note drain plug location.

shaft or journal surface, and thereby compensate for wear, dependable retention of lubricant is accomplished.

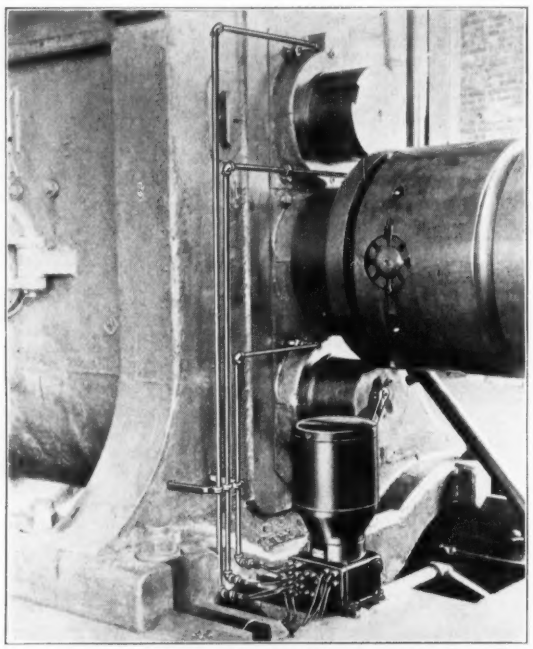
Grease groove seals present a comparatively simple means of overcoming leakage of lighter lubricants under normal temperature conditions. They are also relatively simple and inexpensive to design. On the other hand, they require attention at periodic intervals, for the purpose of renewing the sealing grease. Otherwise, possible glazing of the surface of this latter where it comes in contact with the rotating shaft might result in sufficient clearance to allow leakage of the bearing lubricant. Very heavy bodied greases of high melting point are adaptable to service as grease seals, provided they show no tendency to separate oil from soap, and contain no material which might prove abrasive to the shaft surface. Grease grooves can also be used together with felt washers in certain types of service.

While spring adjusted seals insure more uniform contact between the sealing medium and the shaft, journal, or roll neck, they involve more constructional details and consequently can normally be expected to be more expensive than the more simple types of washer seals.

DRAIN PLUGS

By virtue of the necessity for periodic cleaning of bearings subjected to heavy duty under dirty conditions, it is highly advisable that

suitable provisions be made in the base of the housing for drainage of lubricant and slushing fluid. Normally a suitable plug which can be securely screwed into a drilled and tapped hole will serve the purpose and prevent leakage during operation. Oftentimes this can be



Courtesy of United American Bosch Corp.

Fig. 5—Showing a rolling mill pinion stand, equipped for force feed grease lubrication. Note grease pump and essential piping.

elaborated upon where oil is employed for lubrication by an arrangement of nipples and pipe fittings, terminating in a sight gauge glass. In this way not only is cleaning facilitated, but also the oil level in the bearing can be observed.

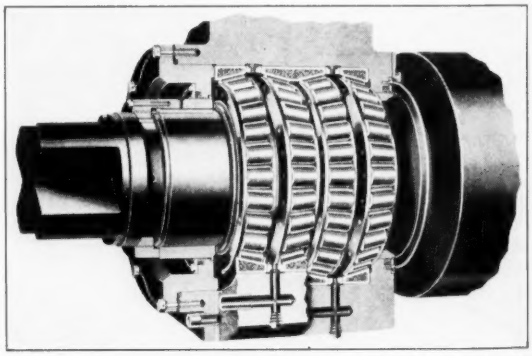
It is important to remember that the maximum protection of any anti-friction bearing is only assured by maintenance of the lubricating system as free from foreign matter as possible. In certain types of operation this can be more easily accomplished than in others; the extent to which dust, dirt, metallic chips or scale may be present in the air or thrown onto the bearing will, of course, be an influencing factor. In steel mill operations this must be particularly borne in mind in the design of anti-friction bearing seals as well as provisions for cleaning, for there is always possibility of entry of non-lubricating abrasive impurities where such a bearing is not properly sealed. The detrimental results which would develop in the form of scored bearing elements, misalignment and the necessity for bearing replacement, with the attendant effect upon production, can be readily realized.

Probably the most intensive duty to which such a bearing can be subjected is continued churning of abrasive foreign matter with oil or grease in intimate contact with the highly polished bearing elements.

For the reason that it is not always possible to effect the requisite degree of sealing or to depend upon the seal being in proper condition at all times, bearings in service such as is involved in the average mill should be flushed and cleaned at periodic intervals. The frequency, of course, will depend upon the design of the bearing, the type of seal, the extent to which dust, dirt, scale or water may be present, and the nature of the lubricant. Some classes of steel or paper mill service will be more subject to contamination of lubricants than others. Roll neck and table roll bearings for example, may suffer in this respect more than those used on cold saws, although the use of oil slingers fastened to shafts or journals have been found to prevent entry of too much foreign matter effectively. Yet, even with such precautions, cleaning of the bearings should not be neglected, for experience has proved that their life can be materially lengthened by such attention.

VENTING OF BEARINGS

In the operation of roller bearings, particularly where external heat conditions may prevail, vent holes have been found of material advantage in relieving possible pressures within the bearings and back pressure upon the lubricants. Vent holes will be particularly advisable on grease lubricated bearings, as an indicator to operators in filling. Were pressure to prevail, with no provision for its relief, proper filling might easily be prevented. Elimination



Courtesy of The Timken Roller Bearing Co.

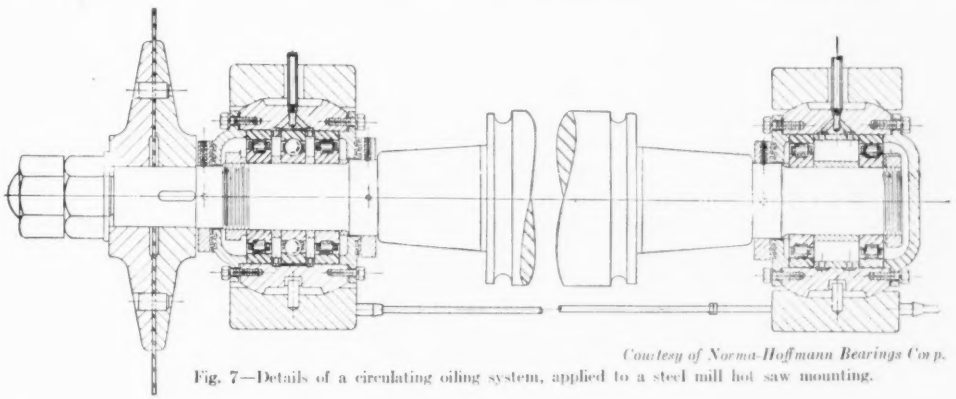
Fig. 6—Showing a four row heavy duty type of tapered roller bearing designed for steel mill roll neck service.

of such pressures within a bearing also serves to prevent possible leakage in event of overheating from external or internal sources, due to the fact that any expansion of the lubricant can occur freely. Should it be restricted, the development of back pressure with no source of relief might cause leakage around the bearing housing, with even the possibility of impaired lubrication.

Steel Mill Developments

Progress in the study of bearing design and methods of lubrication has been extensive in the steel industry, due to the several very definite objectives which machinery operations have presented. Experience has indicated that regardless of individual conditions the average steel mill must give most serious thought to:

Reduction in maintenance costs
Decrease in hazard
More effective usage of labor, and
Reduction in cost and volume of lubricants used.



Courtesy of Norma-Hoffmann Bearings Corp.

Fig. 7—Details of a circulating oiling system, applied to a steel mill hot saw mounting.

Maintenance costs have always been of the utmost importance to the steel mill operator by reason of the relatively large size of the machinery. The weight and bulk of the moving parts and the size of the repair force needed to accomplish replacements all tend to bring the cost of even bearing renewal up to a figure which would be viewed with alarm in virtually any other type of plant. In addition to material and labor costs the value of time lost and accompanying reductions in production amount to a serious item during normal times. One of the most sizeable jobs in the modern steel mill is proper maintenance of the roll neck bearings, which carry the rolls and absorb virtually the full load developed as ingots, bars or billets are passed through the rolls.

Obviously, the expense and labor involved in roll neck replacement have led to intensive study of methods of lubrication and bearing construction. While the first usage of roller bearings was confined to table rolls and mill drives, the roll necks soon attracted attention, particularly on smaller types of mills of the finishing variety. Such bearings have proved to be a practical success due to their ability to carry the prevailing loads, the protection which their seals afford lubrication, and the lower costs of replacement. In regard to this latter it is well to state that while material costs may be higher than the cost of plain bearings, the labor involved will normally be less.

There is, of course, a difference of opinion as to the ability of the roller bearing to carry the loads and withstand the continuous shocks which prevail in rolling mill operations, due to the low actual area of bearing contact. In part, shock absorbing ability will be a function of lubrication, in part dependent upon the nature of the steel from which the rollers and raceways are manufactured. With this thought in mind, lubrication of such bearings is being given most careful study today, with a view to developing lubricants of the highest load carrying and shock resisting capacity.

With the attainment of this particular objective the beneficial results can logically be expected to be threefold:

Operations will be maintained at lower costs for lubrication.
Life of bearings will be increased, with consequent reduction in maintenance costs, and
Hazard will be decreased.

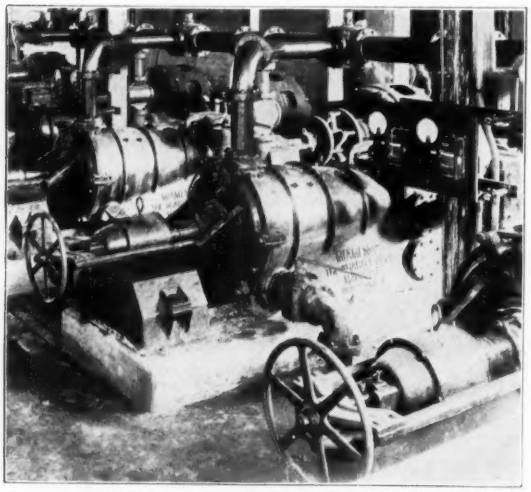
This latter is particularly worthy of a few words. Steel mill operations at best are comparatively hazardous to the operators, due to the virtual necessity of running so many of the moving parts exposed. By use of bearing construction and methods of lubrication which will prolong the interval between application of lubricant, it will enable operators to stay at a safe distance from mill drives, exposed gearing, and out of range of flying scale or hot water splash. Conditions around the bearings will also be cleaner, reducing the chance of accidents to operators through slipping.

CONDITIONS ADVERSE TO EFFECTIVE LUBRICATION

As already stated, steel mill bearings will in general be required to function under condi-

tions decidedly adverse to effective lubrication These will include:

Radiated and conducted heat
Water plus entrained scale
Hardness of steel being rolled



Courtesy of Shartle Brother Machine Co.

Fig. 8—Showing a paper mill jordan installation, equipped with Timken roller bearings.

Bearing Temperatures

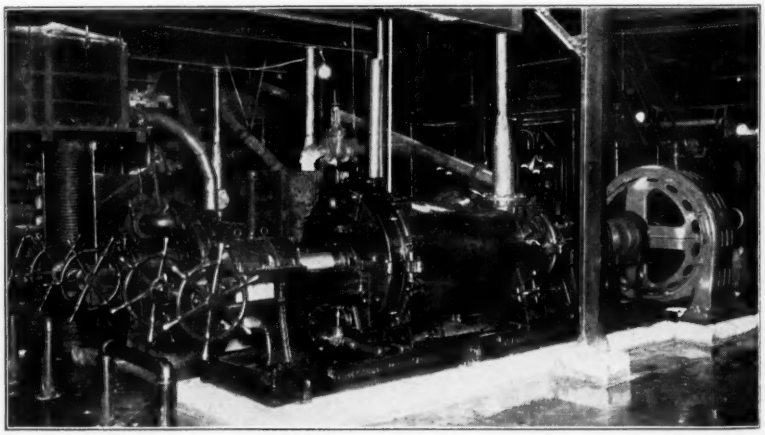
Accurate determination of bearing temperatures, especially in rolling mill operations, is a decided problem. This will be particularly true where water-cooled bearings are involved. Provisions for thermo-electric determination of temperature are, of course, practicable, but the expense of observation and equipment required would prohibit this in the average plant. The only other recourse would be the use of thermometers and wells drilled in the bearing housings. In the roller bearing, however, construction prevents close proximity to the rolling elements, thereby precluding positive observation of the actual temperature under which the lubricant may be operating.

Suffice it to say that temperatures of roll neck and hot saw bearings in particular will normally be sufficiently high to reduce the consistency of virtually any grease to a marked degree. Observation has indicated that certain greases of even the high temperature variety will tend to lose their adhesiveness when subjected to prevailing roll neck temperatures, developing a foamy appearance which could be expected to reduce the load carrying capacity.

The use of heavy viscosity oil stock as the base of such a grease has been proved an aid in enabling the product to retain its intended homogeneity and maintain proper lubrication for a considerable length of time.

Water Plus Contaminating Scale

The extent to which water may be detrimental to effective lubrication of any steel plant roller bearing will depend upon seal construction of the bearing and the possibility of entry of water or abrasive scale. As generally constructed, the roller bearing is better adapted to the retention of lubricant than the plain bearing, particularly where effective sealing media are used. One must not forget, however, that wherever high temperature conditions are involved, the resultant reduction in grease consistency may give rise to a certain amount of leakage from even the most carefully designed bearing. Operation in the presence of hot water will oftentimes aggravate this condition, and even lead to penetration of water into the bearing itself. For this reason the grease used must also be carefully prepared with a view to developing a high degree of water-resisting ability. Hot water, furthermore, causes a continuous temperature condition, giving the bearing practically no chance to cool down to any appreciable extent.



Courtesy of The Noble and Wood Machine Co.

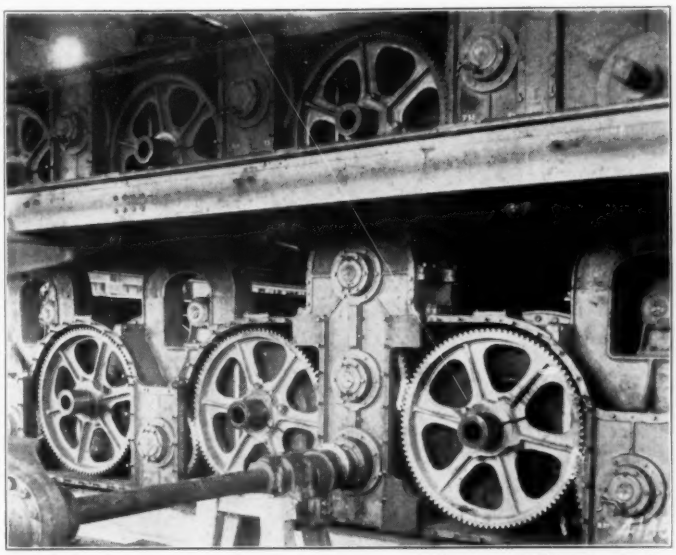
Fig. 9—A Noble and Wood paper mill jordan installation, equipped with heavy duty grease lubricated roller bearings.

Hardness of Steel Being Rolled

The size of steel being rolled, as well as its relative hardness will, in turn, affect bearing lubrication, by virtue of the extent to which intensity and amount of load will be influenced.

The hardness and gauge or thickness of the steel governs the operating pressure on the roll necks, just as the number of pieces rolled per minute govern the peak load. Failure of the lubricant to meet these pressures and prevent metal-to-metal contact or deformation of the bearing elements as these loads are transmitted thereto, will cause abnormal wear of rollers and raceways, throwing the mill out of line. The result will be imperfections in gauge, oftentimes requiring another rolling treatment, especially where steel plates or sheets are being handled. Such conditions can only be corrected by bearing replacement.

The load carrying capacity of the lubricant is, therefore, quite as important as its temperature resisting ability. Fortunately the viscosity characteristic in the mineral oil base is of value in each instance. In other words, the heavier or more viscous the oil, the greater its normal load carrying and temperature resisting ability.

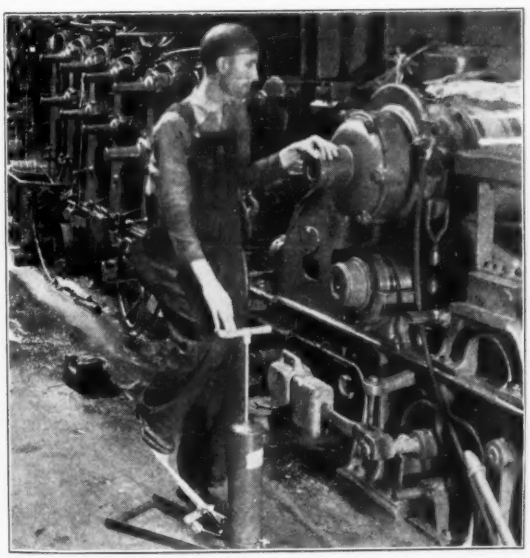


Courtesy of SKF Industries, Inc.

Fig. 10—The driving side of a Pusey and Jones paper machine. Note the compactness of the roller bearing ends.

Paper Mill Service

The jordan engine, as well as the paper machine, has been prominently identified with the adaptation of the heavy duty roller bearing in the paper industry. This tendency toward the adoption of anti-friction bearings, in construction of the more modern types of paper mill machinery, has without a doubt reacted favorably upon the unit cost of lubrication per ton, as well as the costs of upkeep and repair, for they insure against entry of water in the operation of the various roll bearings, and enable the lubricants to resist the pressures involved more effectively.



Courtesy of The Rogers Products Company

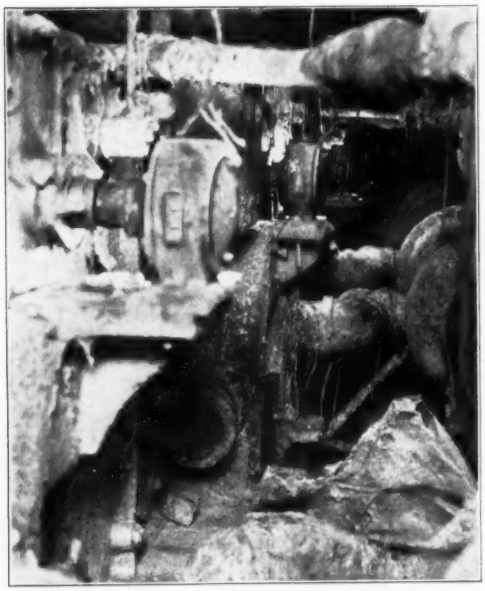
Fig. 11—Showing application of a pressure grease lubricator to the bearings of a paper machine.

The relation of bearing adjustment to maintenance costs and lubrication is of particular interest. As the final stage in the cutting and mixing of paper stock, the jordan is of decided importance, for uniformity of stock must be maintained. Improper fitting of the plug by reason of bearing wear might easily affect the run of finished paper to a sufficient degree to render it incapable of meeting specifications as to finish, weight and texture.

The use of roller bearings of either the helically wound type or solid type has been proved an adjunct in reducing the possibility of improper fitting of the plug, for bearing wear has been found to be markedly reduced, provided proper lubrication is maintained.

The type of lubricant will, of course, depend upon bearing design and construction, as well as the means provided for application. Helically wound bearings are generally grease lubricated. Installations involving solid rollers, however, have been found to function very successfully on straight mineral oil of medium to heavy viscosity. Where oil is used it is,

of course, essential to have comparatively oil-tight bearing construction; otherwise objectionable leakage might occur. Operating experience in connection with jordan engines has indicated that maintenance of a level of not over one and a half inches deep in the base



Courtesy of Norma-Hoffman Bearings Corp.

Fig. 12—Showing the drive side of a paper mill cylinder machine. The advantage of using roller bearings under such conditions is obvious.

of the bearing housing will give effective lubrication.

On the wet end of fourdriner paper machines the table rolls have been extensively equipped with either ball or roller bearings designed for grease lubrication by means of individual pressure gun fittings. Roller bearings, in turn, have been found to be decidedly adaptable to couch and press rolls where pressures are higher than on the table rolls. Here, likewise, pressure grease lubrication has been extensively adopted. Although oil of suitable viscosity is quite satisfactory provided bearing construction enables its being retained, obviously any leakage would lead to impaired lubrication, not only through possible loss of oil, but also entry of water, to result in rusting and corrosion of the bearing elements.

Grease, on the other hand, by reason of the construction of such bearings, will normally remain within the latter and, furthermore, will serve as a seal to prevent undue entry of water. The relative solubility of a grease for such service, however, is important. Certain authorities regard a soluble soda soap product as an adjunct by reason of the fact that in the presence of normal amounts of water it will develop lubricating emulsions. There is no reason why this should be an advantage, if the use of lime soap products of average consistency is carefully carried out. In fact, properly compounded, a non-soluble lime soap grease will retain its original homogeneity and in the presence of average temperatures will afford a better water seal at the ends of the bearings.

The drier end of the modern paper machine has been given considerable study from the viewpoint of oil lubrication. The tendency today is to equip drier rolls with roller bearings. Design has been worked out to enable the use of oil in a very satisfactory manner, the bearings being either individually lubricated or served through a pressure circulating system.

In such service, in view of the temperatures involved, it has been found advisable to use a straight mineral oil in the neighborhood of 750 seconds Saybolt at 100 degrees Fahr.

The Railway Roller Bearing

Operation of railway type bearings requires consideration of:

(a) The tremendous amount of power required for initial movement,

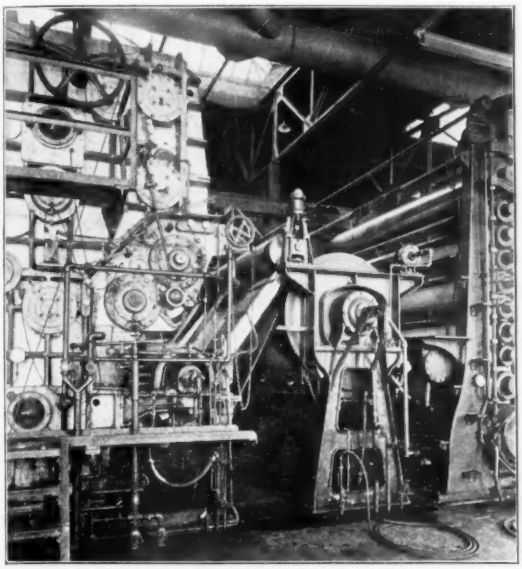
(b) The high frictional resistance which must be overcome by lubrication on heavily loaded modern equipment, and

(c) The potential difficulty of accomplishing lubrication during extremely cold weather.

In plain bearings the theory of effective lubrication is based upon substitution of fluid friction of the lubricant for the harsh solid friction, which would otherwise be developed between the sliding metallic surfaces. Where effective lubrication is maintained, the metals of the bearing parts are separated by a film of lubricant and, in this condition, wear should be reduced to a minimum. Inspection of bearing parts, however, discloses considerable wear, which leads to the following deductions:

For reasons inherent to railway service, the lubricating film, particularly in plain bearings, is unquestionably ruptured at times. If the film is not re-established within a certain period of time, the temperature may rise to the fusing point of the metal, and a hot bearing may result. If, however, the lubricating film is re-established before the metals fuse, while wear will take place during the unlubricated interim, in view of the amount of power required to start a plain bearing from rest, it is reasonable to presume that the major portion of such

wear occurs during initial movements of the journal. This would be especially true where the lubricating film is broken when the journal is at rest. Occurrence of this latter is entirely dependent on the temperature of the bearing parts and the pressure exerted during such



Courtesy of Minton Vacuum Drier Corporation

Fig. 13—The calender end of a Minton Vacuum Drier, equipped with roller bearings.

periods of rest. As a result, journals in this condition start on solid friction, with respect to their bearings, and metallic wear and increased power consumption is involved at the very beginning.

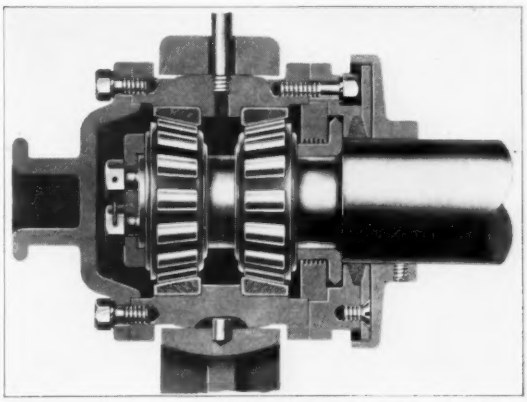
Unfortunately, research facilities are not available to develop adequate data to substantiate a mental picture of the forming of the lubricating film on the railway type of plain bearing. It is reasonable to believe, however, that were one to place a clear glass bearing, through which observations could be made, upon a true journal, one would find but little lubrication existing at the initial movement of the journal, and the greatest frictional resistance indicated at this stage. Continued movement of the journal could be expected to carry sporadic streaks of oil up under the bearing, to reduce somewhat the frictional resistance. As these oil streaks increase, the frictional resistance should decrease proportionately, until the streaks of oil blend into a continuity of film when the minimum frictional resistance, consistent with the viscosity of the oil, should be indicated.

Confining our thoughts exclusively to heavy modern equipment, it is reasonable to state that the number of plain bearings from which the lubrication film is expelled during rest periods will reach a substantial figure. Many others will have the lubricating film only partially expelled. In fact, it is believed that but a slight majority of the whole will retain a working film during the rest period, if this period is not too extensive. In brief, plain bearings of heavy modern equipment, after strenuous duty, may be expected to fall well within the class of semi-lubricated bearings.

Obviously, those bearings from which the lubricating film has been expelled during the rest period require the greater power for initial movement of the journal. Likewise, any bearing from which the lubrication film has been partially expelled requires proportionately more power for initial movement of the journal than will a completely lubricated bearing. In cold weather this will be particularly aggravating, due to congealment of the oil.

ADVENT OF ANTI-FRICTION BEARINGS

The adaptation of the roller bearing to railway equipment has indicated an apparent solution to many of these problems. The roller bearing is not a new thought. Without a doubt, wooden rolls were used for the conveyance of massive portions of building material during the construction of early historical buildings. The development of such



Courtesy of The Timken Roller Bearing Co.

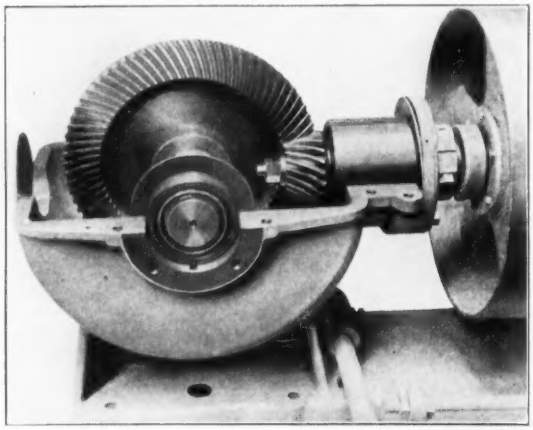
Fig. 14—Showing typical application of the heavy duty roller bearing to the couch roll of the paper machine.

bearings in applied mechanics, however, is strictly the work of the present century. Both ball and roller bearings have proved immensely satisfactory and efficient in all phases of industrial operations, from the lightest high speed devices to the heavy, cumbersome equipment of the steel mills.

The development of roller bearings for railway equipment extends over a considerable period of time, but their successful application is the work of only the past few years, in most cases applied under skepticism, subjected to the keenest criticism, and yet, proving vastly successful in this new field.

The railway roller bearing is a mechanical

structure; being such it must not be expected to be infallible. The construction is such that it entails no more possibility of breakage or wear than any other known railway appliance and quite probably far less. Engineers who have designed railway equipment roller bearings have not only accomplished a welcome achievement but, in addition, they have contributed an appliance that has functioned admirably.



Courtesy of Beloit Iron Works

Fig. 15—Hypoid spiral drive for a paper machine, showing roller bearing installation.

Purpose of Design

The design of railway equipment roller bearings has been wholly influenced by those particular conditions which are involved in the prevailing operations, such as

(a) Tremendous crushing forces from heavy loads at high speeds
(b) Severe hammer blows on rollers and races
(c) Diagonal twisting and jamming of rollers
(d) The terrific lateral thrusts.

To meet these, extensive experiments and tests have been conducted under conditions far more severe than in actual railroad service, for the purpose of establishing a wide factor of safety for this particular service; a factor probably many times that required in any industrial operation.

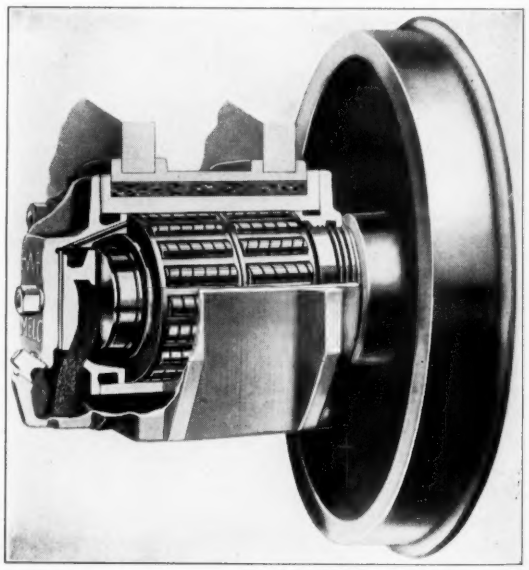
The Principle Involved

While mechanical construction, method of application and means of lubrication of the various types of railway equipment roller bearings differ somewhat in detail, the fundamental principle of all types is the substitution of rolling friction for sliding friction. The construction of such bearings consists of placing a set or sets of rollers between an inner and an outer race, and spacing the rollers in a suitable cage to maintain their alignment, the entire assembly being contained in a box or housing, with a general view of providing flexibility of the bearing and ease of attachment of the assembly to the axles, or mechanisms of the locomotive.

In certain types of railway equipment roller bearings the roller unit assumes both vertical and lateral thrust loads; in others this unit assumes only the vertical thrust load and a separate feature functions to take up the lateral thrust load. A variety of roller designs is presented, such as cylindrical, tapered, and helically wound rollers, with corresponding adaptability of related parts for which the respective manufacturers advance claims of advantage.

The frictional resistance of roller bearings is purely the resistance of the rolls to rolling on the races, plus a slight end resistance in certain types which is developed through their contact on related parts. Journal loads are sustained by and projected through the virtual line contact surfaces of the load carrying rollers and races.

The pressures per square inch of roller bearing contact surface, which exists between rollers and races is far higher than the pressures per square inch of contact surface of plain bearings. This frequently results in microscopic flexing of the metals of the rollers and races, thus offering resistance to movement. This reaction under the tremendous pressures involved obviously develops a certain amount of temperature, dependent upon the type of roller bearing and the prevailing journal loads. On the other hand, the average running temperature of railway roller bearings rarely approaches the average running temperature

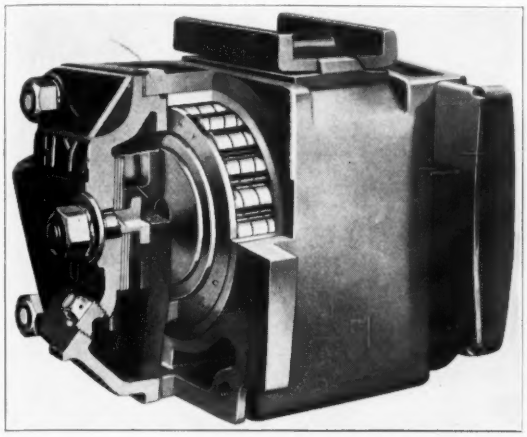


Courtesy of The Fafnir Bearing Co.

Fig. 16—Showing details of the Fafnir Melcher type of roller bearing, applied to steam railway journal service.

of other types of bearings, in most cases it is materially lower.

Theoretically, the direct movement of the rollers on the races should require little, if any lubrication. Deflection of forces, however, creates frictional conditions which can only be



Courtesy of Hyatt Roller Bearing Company

Fig. 17—Showing a Hyatt equipped railway journal box, cut away to show construction. Note location of felt wick at the front of the box.

overcome by lubrication. Hence, the practice of maintaining an ample supply of lubricant at all times when roller bearings are in service, and yet, they will function for unbelievable mileage without damage to rolls and the races in almost total absence of lubrication.

Although pressures are extremely high and clearances range from .002 to .005 of an inch, lubrication of railway equipment roller bearings is simple, consisting of furnishing the original supply of oil and a periodical check of the oil level with a gauge, replenishing the supply where necessary. In all cases, oil is introduced to the bearings through accessibly located openings.

MEANS OF LUBRICATION

The majority of roller bearings now offered for railway service have a direct system of lubrication, the rolls either passing through the oil reservoir or through a body of oil communicating with the reservoir. In some instances lubrication is augmented by an oil flinger. Other types of bearings are provided with a capillary system of lubrication, whereby the oil is fed by capillary action through a wick of special design to a certain level, where it is expelled by pressure from the related parts of the bearing and distributed for the lubrication of the roller and the axle thrust elements.

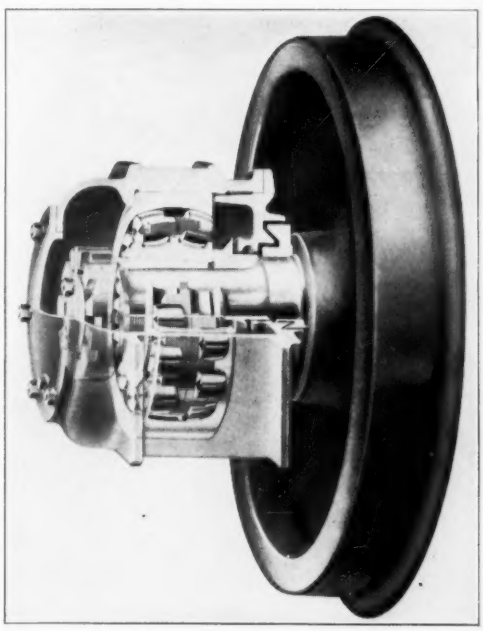
Types of Lubricants

Early applications of railway equipment roller bearings were lubricated with a light grease. This, however, was found to be somewhat unreliable in excessively cold weather. As a result, practically all manufacturers now recommend various grades of straight mineral car oil for the lubrication of their respective bearings. In some cases summer and winter grades of car oil are specified to conform to the respective seasons, while other manufacturers recommend a winter grade of car oil with a zero pour test for all seasons. Still another specifies a heavy, high flash mineral cylinder oil, suggesting a complete renewal every six months.

Manufacturers' specifications covering the grade of lubricant best suited to the lubrication of their respective bearings appear to be still an open subject. The preponderance of opinion however, leans toward a straight mineral car oil, having a viscosity of from 650 to 750 seconds Saybolt at 100 degrees Fahr., for normal warm weather conditions, and 175 to 300 seconds for cold weather conditions.

Due to a close mechanical resemblance in general principles, regardless of manufacture, it is reasonable to expect that any properly refined grade of car oil, within the above viscosity range, should be able to lubricate all types satisfactorily.

The initial supply of oil for lubricating the average roller bearing is normally less than the

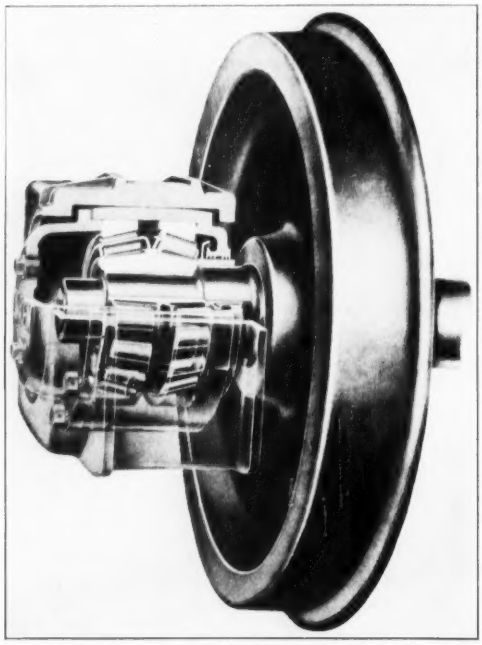


Courtesy of SKF Industries, Inc.

Fig. 18—Details of an SKF type of journal bearing.

amount of oil contained in the packing used on plain bearing equipment. Service is light and the general consumption of oil is less than that in plain bearings, except where manufacturers recommend a periodical change. A number of test cars have accumulated a mileage in excess

of 80,000 miles on roller bearings without any addition to the original oil supply, and an analysis of the oil then removed revealed it to be probably serviceable for many thousand



Courtesy of The Timken Roller Bearing Co.

Fig. 19—Xray view of a Timken roller bearing, as applied to railway passenger equipment.

miles of further service, for it was free from objectionable foreign matter, such as is always found in car oil removed from journal box packing associated with plain bearings.

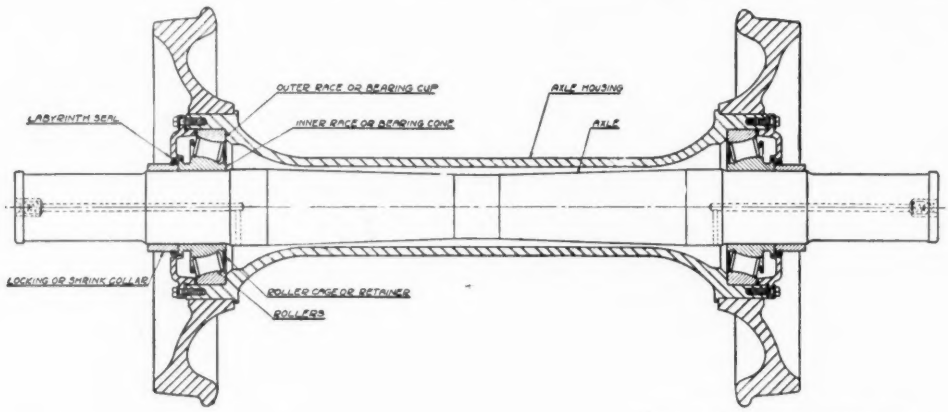
CONCLUSION

In modern industrial and railway operation, production, speed and quality are the essentials of any contract, whether it involves the rolling of structural steel, manufacture of newsprint or the transportation of passengers or freight. The relation of speed to smoothness in operation is obvious. It has been the purpose of this article to bring out the relation of bearings to this latter.

The anti-friction bearing is still in the stage of development, and is the subject of considerable controversy; there are many adherents to the plain bearing who are not convinced that the roller bearing can do all that its sponsors claim for it.

Be that as it may, this matter of quality and speed is worthy of a few words summing up. As one looks out of a pullman car window it will be noted that all motor vehicles run as fast or faster than the average passenger train. To compete with other forms of transportation a general speeding up of railway service seems imperative. Speeding up of trains does not involve shortening the running time between given points, but rather the maintenance of consistent movement, free from interruption at terminals and en route. Material increase of train speed embraces numerous conditions, involving power, equipment, track grade, curvature, elevation, signalling facilities, etc. None of these factors can be overcome without due consideration and preparation. This gives greater importance to uninterrupted service, thereby suggesting the advantages to be gained from the most adaptable bearing construction.

Continued operation with the utmost precision as an added factor is the essential likewise in industry, wherein heavy duty may impose severe strain upon machinery bearings. The steel and paper industries, being noteworthy in this regard, have been considered jointly with the railroads.



Courtesy of Shafer Bearing Corporation

Fig. 20—Sectional drawing of an A. S. F. roller bearing unit showing Shafer self-aligning roller bearings and the details of construction with respect to lubrication.

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